

# PATENT SPECIFICATION

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## COMPLETE SPECIFICATION

### Improvements in and relating to Turbines

5 We, SCHWEIZERISCHE LOKOMOTIV- UND MASCHINENFABRIK, a Joint Stock Company organised under the Laws of Switzerland, of 41, Zürcherstrasse, Winterthur, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 As is well known, the efficiency at partial load of axial- or radial-flow compressors and gas turbines is low, when compared with the results obtained with internal combustion piston engines. An improvement of the partial  
15 load efficiency may be realised, as is also well known, by the use of rows of adjustable blades, an arrangement adopted more particularly in hydraulic turbine practice. In the case of thermal turbines considerable difficulties  
20 are encountered in the use of adjustable blades, on account of the high temperatures which occur in such engines. For this reason the adjustable blade has been used in only very few cases.

25 A special object of the present invention is to obtain a better pressure tightness and temperature insensitiveness of a guide blade ring with adjustable blades.

30 In a known kind of guide blade ring with adjustable blades the latter are supported in an overhung position, which is accompanied by the disadvantage, that the clearance between the smooth blade ends and the wheel hub has to be made relatively great, more particularly in the case of high pressure turbines,  
35 in order not to endanger operational safety. The pressure tightness is, however, thereby impaired. In the case of adjustable guide blades of axial-flow turbine-engines there is, moreover, an additional enlargement of the  
40 guide blade clearance at the extreme guide blade positions, when it is not possible to make the free end surfaces of the blades and the adjacent rotor surface spherical.

45 U.K. Patent Specification No. 736,796 describes and claims a bladed stator structure, for an axial flow machine, of the kind in which

the blades have adjustable swirl-imparting characteristics and in which stator parts, such as blade shrouds or labyrinth seal elements, are supported adjacent the rotor part of the machine at the inner ends of the stator blades, which structure comprises an outer supporting member, a plurality of stator blades of aerofoil section, each of which stator blades is divided longitudinally into parts whereof the trailing part is mounted for angular adjustment relative to the leading part of the blade to maintain an aerofoil section with substantially continuous surfaces, and the leading parts of the blades are fixed in said supporting member and are adapted or arranged by their inner ends to support other parts of the stator structure between two rotating parts of the machine.

U.K. Patent Specification No. 774,501 describes and claims an elastic fluid turbine stator blade assembly wherein the blade comprises a fixed forward part incorporating the blade leading edge and a rear part incorporating the blade trailing edge, which rear part is pivotable with respect to the fixed part about an axis extending substantially along its forward edge, means being provided for cooling the fixed part of the blade.

The invention consists in a guide blade ring for axial-flow turbine engines of thermal type, more especially for axial-flow gas turbines, which is arranged in an annular channel of the turbine, the channel being formed by two concentric rings, and of which the blades consist on the inlet side of a fixed part and on the outlet side of a part pivotally movable relatively to the fixed part, the fixed blade parts rigidly connecting the outer ring to the inner ring serving as carrier for a labyrinth packing whereas the movable blade parts are mounted both in the outer and in the inner ring and are separated from the stationary blade parts by a gap extending concentrically with the pivotal axis, characterised in that the separation between the stationary and movable blade parts is located in the region of greatest blade thickness and the sector angle

of the circular arc profile of the pivotally movable blade parts is of such magnitude that even in the most extreme regulating positions of the pivotally movable blade parts a tangential continuation of the profile of the fixed blade parts is ensured.

A constructional example of the arrangement according to the invention is illustrated in the accompanying drawing, in which:—

Fig. 1 shows a longitudinal section through a gas turbine guide blade ring and the adjacent sets of rotor blades;

Fig. 2 is a cross-section through the guide blade ring on the circular section plane II—II of Fig. 1 and

Fig. 2a is a special construction of the guide blades.

In the casing 1 of an axial flow gas turbine the guide blade ring 2 provided with adjustable blades is disposed between the adjacent rotor blade sets 3, 4 of the rotor 5. The blade rings are swept through in the direction of the arrows 6 by the hot gases.

The guide blades are made in two parts. On the inlet side they consist of the fixed blade parts 8 which form a rigid connection between the outer and inner blade-supporting ring 9 and 10 respectively. On the outlet side they consist of the rotatable blade parts 11. Nevertheless, in each case the two parts form a whole, their bounding surfaces continuing one another in faired fashion with only a narrow gap 12, 13. This is rendered easier by making the part 14 of the movable blade parts 11, which is adjacent to the fixed blade parts 8, with a profile in the form of a circular arc, so that the profile of the fixed blade parts forms a tangential continuation of this circular arc, and the separation between the stationary and the movable blade parts is located in the region of greatest blade thickness, as can be seen in the drawing. At the same time, the sector angle  $\gamma$  of the circular arc profile 14 is of such magnitude that even in the most extreme regulating positions 11<sup>a</sup> and 11<sup>b</sup> of the movable blade parts 11, a tangential continuation of the profile of the fixed blade parts is still ensured. In the embodiment illustrated, the angle  $\gamma$  is greater than 180° and the ratio of the length L of the movable blade part to the blade ring pitch T is greater than 1.0, so that even in the case of adjustment to partial load there is still a channel shape favourable to flow, as is clear from the drawing.

The displacement of the movable guide blade parts is effected by levers 16 which are clamped firmly on the pivot pins 20 of the blades and engage in a common adjusting ring 21.

The connection between the inner and outer supporting ring, brought about by means of the fixed guide blade parts, makes it possible pivotally to support the movable guide blade parts 11 at their inner end by

means of pivot pins 17. For this purpose the inner supporting ring is divided in the plane of the pivoting axes and the two ring halves 10 and 10a are screwed together. As compared with the overhung arrangement this arrangement is firmer and has greater vibration strength. More particularly, the rigid guide blade bridge connection allows of the pressure packing labyrinth 18 provided at the inner supporting ring 10, 10a between the guide sets 3 and 4 being accurately centered with respect to the intermediate ring 19 of the rotor 5 and the fluid-tightness being made very effective. With these expedients the radial air gaps can be reduced to 1/1000 of the packing radius.

A special formation of the guide blades as regards cooling possibility is shown in Fig. 2a. In this case the fixed guide blade part 8 has a cavity 23 which is open towards the movable blade part 11. At the outer blade end the cavity 23 is in communication with a cooling air conduit. The cooling air entering into the cavity emerges through the two gaps 12 and 13 into the spaces 25 between the blades, with the object of preventing a coking up of the gaps. In addition, the emerging bands of air have the effect, more particularly on the convex side of the blades, that cavitation of the flow is prevented and that the surfaces of the movable blade parts 11 are cooled.

In Fig. 2a the movable blade part 11 is also shown with a cavity 26. This cavity is in communication through ducts 27 with the cavity 23 of the fixed blade part and through apertures 28, 29, 30 with the blade ducts 25 on either side, so that a stream of air is blown, not only through the gaps 12, 13 but also through the cavity 26 and through the apertures 28, 29, 30 and thereby additionally cools the movable blade part.

Instead of connecting, as shown each hollow space 23 of the fixed guide blade part 8 to the cooling air supply, the hollow space 26 of the movable blade parts could be connected to it, in which case the hollow space 23 would be fed with cooling air from the movable blade part.

The air blowing apertures 28, 29, 30 might be arranged, instead of as shown, only in the vicinity of the inner blade supporting ring 10a, so that the flow of hot gas, which is admitted to the foot part 34 of the rotor 4, will assume a lower temperature than the flow of gas lying outside in the radial direction. By this means those blade parts which are subjected to the greatest mechanical stresses are cooled.

#### WHAT WE CLAIM IS:—

1. Guide blade ring for axial-flow turbine engines of thermal type, more especially for axial-flow gas turbines, which is arranged in an annular channel of the turbine, the channel being formed by two concentric rings, and of which the blades consist on the inlet side of

- a fixed part and on the outlet side of a part pivotally movable relatively to the fixed part, the fixed blade parts rigidly connecting the outer ring to the inner ring serving as carrier for a labyrinth packing whereas the movable blade parts are mounted both in the outer and in the inner ring and are separated from the stationary blade parts by a gap extending concentrically with the pivotal axis, characterised in that the separation between the stationary and movable blade parts is located in the region of greatest blade thickness and the sector angle of the circular arc profile of the pivotally movable blade parts is of such magnitude that even in the most extreme regulating positions of the pivotally movable blade parts a tangential continuation of the profile of the fixed blade parts is ensured.
2. Guide blade ring as claimed in Claim 1, characterised in that the sector angle is greater than  $180^\circ$ .
3. Guide blade ring as claimed in Claim 1 or 2, characterised in that the ratio of the length of the movable blade part to the blade ring pitch is greater than 1.0, so that even in the case of adjustment to partial load there is still a channel shape favourable to flow.
4. Turbine guide blade ring as claimed in any one of the preceding claims, characterised by the feature that in each case the movable blade part also contains at least one cavity and that this cavity is in communication with

a cavity of the fixed blade part through ducts.

5. Turbine guide blade ring as claimed in Claim 4, characterised by the feature that in each case the cavity of the movable blade part is connected to a cooling medium supply duct and is adapted to pass on the flow of cooling medium through ducts to the cavity of the fixed part.

6. Turbine guide blade ring as claimed in Claim 4, characterised by the feature that in each case the cavity of the movable blade part has blow out apertures which are in communication with the blade ducts.

7. Turbine guide blade ring as claimed in Claim 6, characterised by the feature that at least a portion of the blow out apertures of the movable blade part are directed towards the blade feet of the following rotor blade ring.

8. Turbine guide blade ring as claimed in any of the preceding claims, the inner supporting ring of which has a labyrinth gland between the preceding and the following rotor stage, characterised by the feature, that the radially measured air gaps of the labyrinth gland amount to at most  $1/1000$  of the gland radius.

9. The improved turbine guide blade ring with adjustable blades disposed between two supporting rings of the turbine, substantially as hereinbefore described and as illustrated in and by the accompanying drawing.

MARKS & CLERK.

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1 SHEET

COMPLETE SPECIFICATION  
This drawing is a reproduction of  
the Original on a reduced scale.

